Types of Forces

Terms, Symbols, and Definitions

- Force - a push or pull upon an object resulting from the object's interaction with another object. Forces only exist as a result of an interaction.
- Contact Forces - those types of forces which result when the two interacting objects are perceived to be physically contacting each other.
- Action-at-a-Distance Forces - those types of forces which result even when the two interacting objects are not in physical contact with each other, yet are able to exert a push or pull, despite their physical separation.

Examples of Forces

Contact Forces

- Frictional Force
- Tension Force
- Normal Force
- Air Resistance Force
- Applied Force
- Spring Force

Action-at-a-Distance Forces

- Gravitational Force
- Electrical Force
- Magnetic Force

Units

- Force is a quantity which is measured using the standard metric unit known as the Newton
- A Newton is abbreviated by a “N.”
- To say “10.0 N” means 10.0 Newtons of force. One Newton is the amount of force required to give a 1-kg mass an acceleration of 1m/s/s. Thus, the following unit equivalency can be stated:

$$1\ \text{Newton} = 1\ \text{kg} * \frac{\text{m}}{\text{s}^2}$$

Vectors

- A force is a vector quantity
- A quantity which has both magnitude and direction
- To fully describe the force acting upon an object, you must describe both the magnitude (size or numerical value) and the direction.

- For Example:
  - 10 Newtons is not a full description of the force acting upon an object. In contrast, 10 Newtons, downwards is a complete description of the force acting upon an object; both the magnitude (10 Newtons) and the direction (downwards) are given.

Type of Force	Description of force
Applied Force F_{app}	An applied force is a force which is applied to an object by a person or another object.
Gravity Force (also known as Weight) F_{grav}	The force of gravity is the force with which the earth, moon, or other massively large object attracts another object towards itself. By definition, this is the weight of the object. The force of gravity on earth is always equal to the weight of the object as found by the equation: **$F_{grav} = m * g$** **where g = 9.8 m/s^2 (on Earth) and m = mass (in kg)**
Normal Force F_{norm}	The normal force is the support force exerted upon an object which is in contact with another stable object.

Type of Force	Description of force
Friction Force F_{frict}	The friction force is the force exerted by a surface as an object moves across it or makes an effort to move across it.
Air Resistance Force F_{air}	The air resistance is a special type of frictional force which acts upon objects as they travel through the air. The force of air resistance is often observed to oppose the motion of an object.
Spring Force F_{spring}	The spring force is the force exerted by a compressed or stretched spring upon any object which is attached to it.
Tension Force F_{tens}	The tension force is a force which is transmitted through a string, rope, cable or wire when it is pulled tight by forces acting from opposite ends

Mass VS Weight

Mass

- The mass of an object refers to the amount of matter that is contained by the object
- Mass is related to how much *stuff* is there
- The mass of an object (measured in kg) will be the same no matter where in the universe that object is located
- Mass is never altered by location, the pull of gravity, speed or even the existence of other forces
- For example, a 2-kg object will have a mass of 2 kg whether it is located on Earth, the moon, or Jupiter; its mass will be 2 kg whether it is moving or not (at least for purposes of our study); and its mass will be 2 kg whether it is being pushed upon or not.

Weight

- the weight of an object is the force of gravity acting upon that object
- weight is related to the pull of the Earth (or any other planet) upon that *stuff*
- the weight of an object (measured in Newtons) will vary according to where in the universe the object is
- Weight depends upon which planet is exerting the force and the distance the object is from the planet
- Weight, being equivalent to the force of gravity, is dependent upon the value of g. On earth's surface g is 9.8 m/s^2
- Furthermore, the g value is inversely proportional to the distance from the center of the planet. So if we were to measure g at a distance of 400 km above the earth's surface, then we would find the g value to be less than 9.8 m/s^2

Sliding VS Kinetic Friction

- As mentioned above, the friction force is the force exerted by a surface as an object moves across it or makes an effort to move across it. There are two types of friction force - static friction and sliding friction
- **Sliding friction** results when an object slides across a surface.

$$\textbf{Sliding } F_{frict} = \mu_{sliding} \bullet F_{norm}$$

The symbol $\mu_{sliding}$ represents the **coefficient of sliding friction**

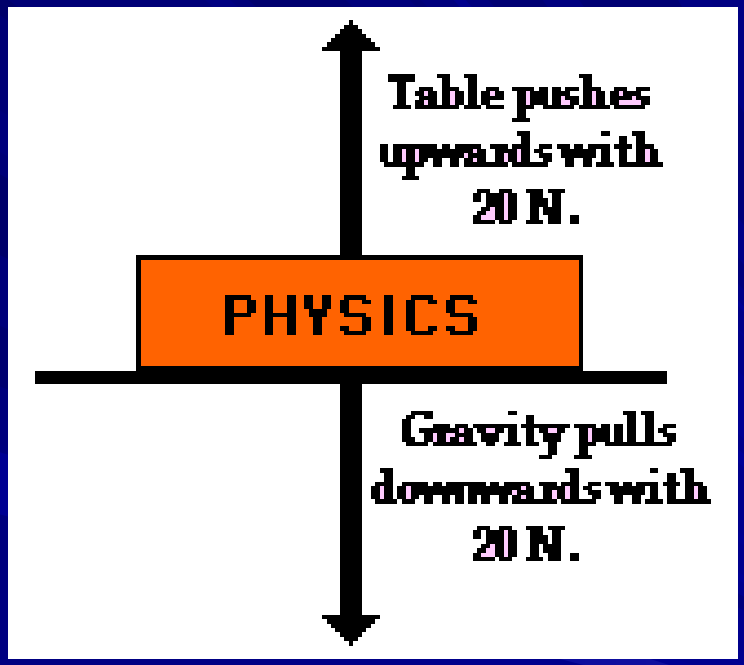
- **Static Friction** results when the surfaces of two objects are at rest relative to one another and a force exists on one of the objects to set it into motion relative to the other object.

$$\textbf{Sliding } F_{frict} \leq \mu_{sliding} \bullet F_{norm}$$

The symbol $\mu_{sliding}$ represents the **coefficient of static friction** between the two surfaces.

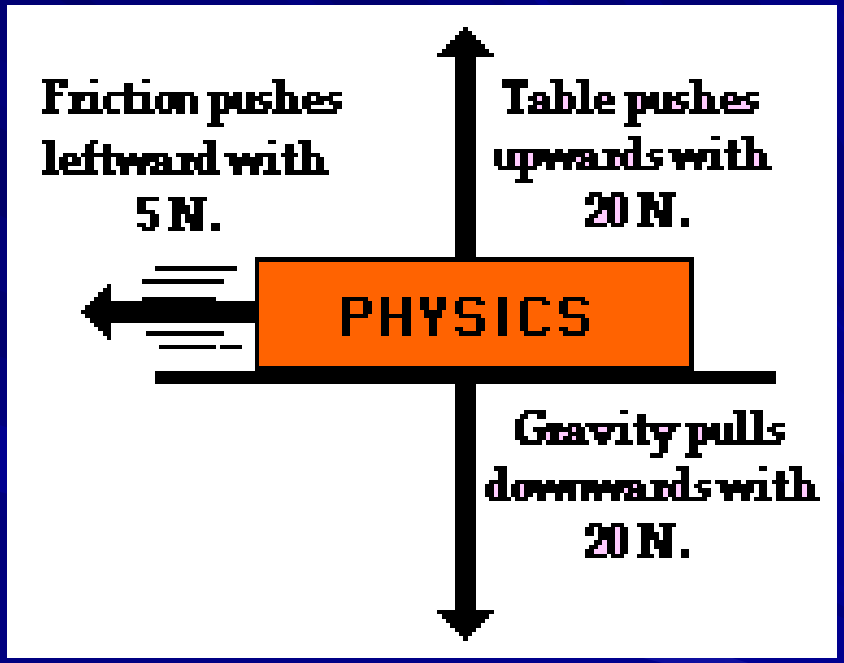
Balanced Forces

- Because a force is a vector which has a direction, it is common to represent forces using diagrams in which a force is represented by an arrow
- The size of the arrow is reflective of the magnitude of the force and the direction of the arrow reveals the direction which the force is acting
- Furthermore, because forces are vectors, the affect of an individual force upon an object is often canceled by the affect of another force
- For example, the affect of a 20-Newton upward force acting upon a book is *canceled* by the affect of a 20-Newton downward force acting upon the book. In such instances, it is said that the two individual forces *balance each other*; there would be no unbalanced force acting upon the book.



Unbalanced Forces

- Other situations could be imagined in which two of the individual vector forces cancel each other ("balance"), yet a third individual force exists that is not balanced by another force.
- For example, imagine a book sliding across the rough surface of a table from left to right. The downward force of gravity and the upward force of the table supporting the book act in opposite directions and thus balance each other. However, the force of friction acts leftwards, and there is no rightward force to balance it. In this case, an unbalanced force acts upon the book to change its state of motion.



Practice

Complete the following table showing the relationship between mass and weight.

Object	Mass (kg)	Weight (N)
Melon	1 kg	?
Apple	?	0.98 N
Turtle	25 kg	?
The Rick	?	980 N

Answers

Object	Mass (kg)	Weight (N)
Melon	1 kg	9.8 N
Apple	0.1 kg	0.98 N
Turtle	25 kg	245 N
The Rick	100 kg	980 N

Practice

Different masses are hung on a spring scale calibrated in Newtons.

The force exerted by gravity on 1 kg = 9.8 N.

The force exerted by gravity on 5 kg = ? N.

The force exerted by gravity on ? kg = 98 N.

The force exerted by gravity on 70 kg = ? N.

Answers

The force exerted by gravity on 1 kg = 9.8 N.

The force exerted by gravity on 5 kg = 49 N.

The force exerted by gravity on 10 kg = 98 N.

The force exerted by gravity on 70 kg = 686 N.

Practice

When a person diets, is their goal to lose mass or to lose weight? Explain.

Answers

When a person diets, is their goal to lose mass or to lose weight? Explain.

Generally, people diet because they wish to reduce the amount of matter on their body - they wish to remove the *blubber*. So people diet **to lose mass**.

Practice

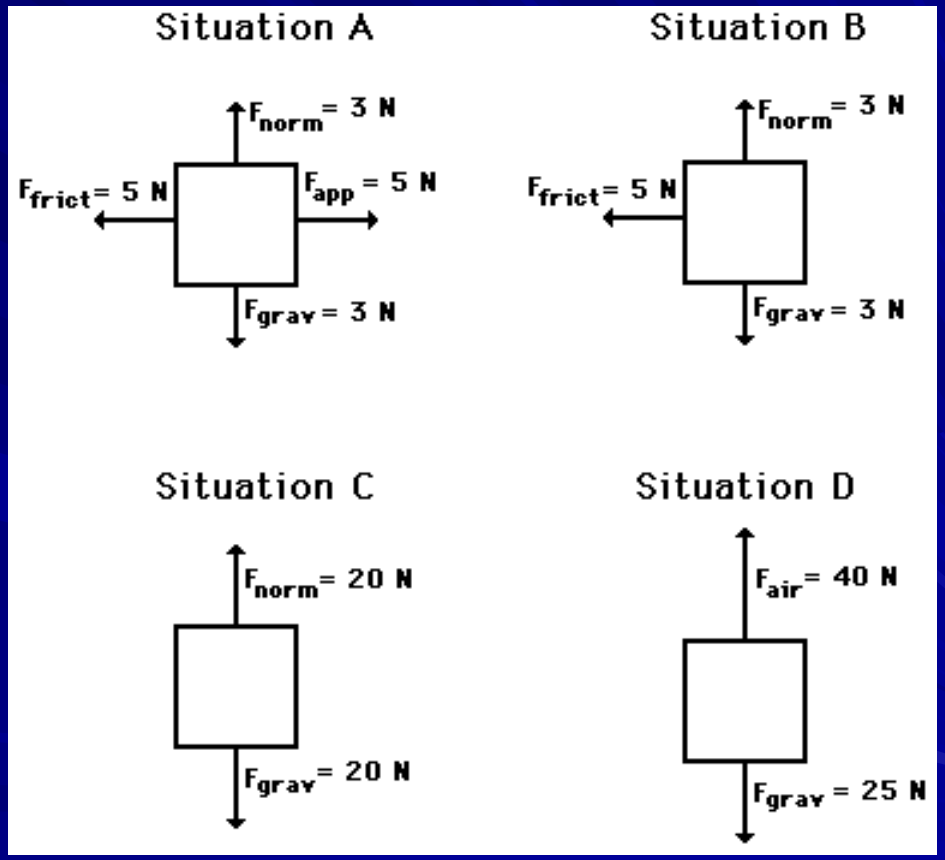
Are these situations balanced or unbalanced?

Situation A: ?

Situation B: ?

Situation C: ?

Situation D: ?



Answers

Are these situations balanced or unbalanced?

Situation A: **Balanced**

Situation B: **Unbalanced**

Situation C: **Balanced**

Situation D: **Unbalanced**